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Email: hello@contoureducation.com.au

VCE Chemistry ½
Stoichiometry [0.15]
Workshop

Error Logbook:

New Ideas/Concepts	Didn't Read Question
Pg / Q #: _____ Notes:	Pg / Q #: _____ Notes:
Algebraic/Arithmetic/ Calculator Input Mistake	**Working Out Not Detailed Enough**
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Section A: Recap (6 Marks)

Learning Objective: [2.3.1] - Write Balanced Chemical Equations

- **To Balance an Equation:**
  - Change the [coefficient] / [subscript].
  - Subscripts and superscripts [can] / [cannot] be altered when balancing an equation.
  - Leave any atoms that are 'isolated' or 'exist on their own' to balance [first] / [last].

Learning Objective: [2.3.2] - Apply Stoichiometry to Find the Amount of Another Substance Used / Produced

- _____ **ratios** are used to convert between the **amounts** of substances in a chemical equation.
- **To Perform Stoichiometry:**
  - [Multiply] / [Divide] by the coefficient of the chemical whose amount is **known**, to **reset** it to _____.
  - [Multiply] / [Divide] by the coefficient of the chemical whose amount is **unknown** (being solved for).
  - Stoichiometric ratios are based on [moles] / [mass] and not [moles] / [mass].
  - **Can Be Thought of As:**

$$\frac{[unknown]/[known]}{[unknown]/[known]}$$

- **Stoichiometry Calculation Steps:**
  - Write the **balanced** chemical equation (if not already given).
  - Find the [mass] / [moles] of the substance provided.
  - Use stoichiometric ratios to find the amount of the unknown substance.

Learning Objective: [2.3.3] - Identify the Limiting Reagent When Reactants' Amounts are Known

- **Limiting and Excess Reagents**
  - The limiting reagent is the one that is [fully consumed] / [leftover].
  - The excess reagent is the one that is [fully consumed] / [leftover].
  - _____ must be compared when determining what the limiting reagent is.
- **Limiting Reagent Determination**
  - **Steps:**
    1. Find [mass] / [moles] of each reactant.
    2. [Multiply] / [Divide] each reactant amount by its _____.
    3. Limiting reagent has a [greater] / [lesser] amount.

Learning Objective: [2.3.4] – Apply Limiting Reagent to Calculate the Mass of Product(s) Formed, and to Calculate the Amount of Excess Reagent Leftover

- The amount of product formed is dependent on the [limiting] / [excess] reagent.
- **For Excess Reagent Calculations:**

  Firstly, identify what the excess reagent is. To find how much of the excess reagent is leftover:

  1. Find $n(excess)_{reacted}$ by using _____ with the _____ reagent.
  2. $n(excess)_{leftover} =$

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Question 1 Walkthrough.

When an antacid tablet is used, calcium hydroxide ($Ca(OH)_2$) interacts with hydrochloric acid (HCl) in the stomach to form inert calcium chloride ($CaCl_2$) and water.

a. Write the balanced chemical equation that occurs.

b. If the molar mass of Calcium hydroxide ($Ca(OH)_2$) is 75 g/mol, find the amount of moles of HCl that are required to fully react with 150 g of $Ca(OH)_2$.

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Question 2 (6 marks) **Walkthrough.**

Consider the following chemical equation:

$$2Ca(s) + O_2(g) \rightarrow 2CaO(s)$$

a. If 60 g of Ca is reacted with 32 g of O_2, identify the excess and limiting reagents. (2 marks)

b. Identify what mass of calcium oxide would form from this reaction. (2 marks)

c. How much of the excess reagent would be remaining after this reaction? (2 marks)

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Section B: Warm Up (13 Marks)

INSTRUCTION: 13 Marks. 8 Minutes Writing.

Question 3 (3 marks)

Balance the following chemical equations:

a. $P_4O_6(s) + I_2(g) \rightarrow P_2I_4(s) + P_4O_{10}(s)$. (1 mark)

_____

b. $Na(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)$. (1 mark)

_____

c. $Mg_2Si(s) + H_2O(l) \rightarrow Mg(OH)_2(aq) + SiH_4(g)$. (1 mark)

_____

Question 4 (5 marks)

How many grams of lead (II) chloride is produced from the reaction of 15.3 g of NaCl and 60.8 g of $Pb(NO_3)_2$?

Ensure to state both the limiting and excess reagent, alongside identifying the full balanced equation.

_____

_____

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_____

Question 5 (5 marks)

Take the following reaction between solid sulphur and oxygen gas.

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(s)$$

a. In one reaction, a chemist reacts 3.45 g of sulphur in order to form SO_3. What mass of sulphur trioxide would form if all of this sulphur is to react? (3 marks)

b. In another reaction, 153 g of sulphur trioxide was formed. What amount of oxygen would have been required in this reaction? (2 marks)

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Section C: Ramping Up (8 Marks)

INSTRUCTION: 8 Marks. 6 Minutes Writing.

Question 6 (1 mark)

Which of these reactions are correctly balanced?

A. $2Fe + 3O_2 \longrightarrow 2Fe_2O_3$

B. $2KCl + Cu(NO_3)_2 \rightarrow CuCl_2 + 2KNO_3$

C. $2AgNO_3 + Na_2SO_4 \rightarrow 2AgSO_4 + 2NaNO_3$

D. $C_2H_6 + 3O_2 \rightarrow 2CO + 3H_2O$

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Question 7 (7 marks)

Consider the reaction between pure sodium and water.

a. Write the full balanced equation between these reactants. (1 mark)

_____

b. If 36 *g* of sodium reacts with 53 *g* of water, identify the excess and limiting reagents. (2 marks)

_____

_____

_____

c. Identify the mass of the gaseous product that will be formed in this reaction. (2 marks)

_____

_____

d. How much of the excess reagent would be remaining after this reaction? (2 marks)

_____

_____

_____

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Section D: Getting Trickier I (10 Marks)

INSTRUCTION: 10 Marks. 8 Minutes Writing.

Question 8 (1 mark)

What is the balanced equation for the reaction between butane gas and oxygen gas, given that there is an abundance of oxygen gas and the reaction was conducted at 25°C?

A. $C_4H_{10}(g) + 13O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(g)$

B. $C_4H_{10}(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(g)$

C. $2C_4H_{10}(g) + 13O_2(g) \longrightarrow 8CO_2(g) + 10H_2O(l)$

D. $C_4H_{10}(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 5H_2O(l)$

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Question 9 (9 marks)

Aleena develops a fascination for explosions and begins intensive research into combustion equations and reactions.

a. What is the difference between a complete and incomplete combustion reaction? (1 mark)

_____

_____

b. Write the combustion equation for the following fuels:

i. C_3H_8. (1 mark)

_____

ii. CH_3CH_2OH. (1 mark)

_____

iii. C_3H_{18}. (1 mark)

_____

c. One of the fuels Aleena combusts is methane - CH_4. She takes a total of 500 grams of methane and combusts it in excess of oxygen.

i. Identify the mass of oxygen which would have been consumed for this reaction. (3 marks)

_____

_____

_____

_____

ii. What mass of water would be produced via this reaction? (2 marks)

_____

_____

Section E: Getting Trickier II (11 Marks)

INSTRUCTION: 11 Marks. 10 Minutes Writing.

Question 10 (11 marks)

An unknown compound is being analysed for its contents.

a. It is identified that the compound is comprised of 38.7% K, 13.8% N, and the remainder is oxygen.

i. Calculate the empirical formula of this compound. (2 marks)

_____

_____

_____

_____

ii. What is the molar mass given that the molecular ratio is 1: 1? (1 mark)

_____

b. A $5.66 \times 10^{-1}\ g$ sample of the compound is then reacted with $8.44 \times 10^{-1}\ g$ of $(CH_3COO)_2Cu$.

i. Write the balanced equation. (1 mark)

_____

ii. Identify the limiting and excess reagents. (2 marks)

_____

_____

_____

_____

iii. Find the mass leftover of the excess reagent. (2 marks)

_____

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c. Given the amounts above, find the mass of the product(s) formed. (2 marks)

_____

_____

_____

_____

d. Find the mass of the precipitate formed. (1 mark)

_____

_____

Let's take a BREAK!

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Section F: VCAA-Level Questions I (10 Marks)

INSTRUCTION: 10 Marks. 30 Seconds Reading. 10 Minutes Writing.

Question 11 (10 marks)

Ethanol is an important liquid chemical used in industry that is also toxic to humans. It is also known to be combustible.

a. Write the fully balanced combustion reaction between ethanol and excess oxygen gas, assuming the reaction occurs at 25°C. (1 mark)

_____

b. Ethanol is added to traditional petrol (C_8H_{18}) to reduce the harmful emissions that enter the atmosphere.

i. Given that, there exists $2.44 \times 10^3\ g$ of ethanol, calculate the amount of CO_2 emitted, in kg. (2 marks)

ii. In 2025, the standard light vehicle emission standard is going to be set to $105\ g$ of CO_2 per km of travel.

Given that the above amount of ethanol was combusted, and the same amount of C_8H_{18} was also fully combusted for a particular vehicle, find the maximum amount of kilometres it should travel. (4 marks)

c. The distance between Glen Waverley Station and Huntingtower is approximately 2.5 kilometres. The emission rate for the vehicle was measured to be 85 g of CO_2 per kilometre. The vehicle in use entirely depends on ethanol.

Find the amount, in grams, of ethanol required to make this journey. (3 marks)

_____

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_____

Space for Personal Notes

Section G: Multiple Choice Questions (9 Marks)

INSTRUCTION: 9 Marks. 9 Minutes Writing.

Question 12 (1 mark)

When 1.0 mole of Cu_3FeS_3 and 1.0 mole of O_2 are mixed and allowed to react according to the equation:

$$2Cu_3FeS_3(s) + 7O_2(g) \rightarrow 6Cu(s) + 2FeO(s) + 6SO_2(g)$$

A. No reagent is in excess.

B. 5 mole of O_2 is in excess.

C. $\frac{5}{7}$ mole of Cu_3FeS_3 is in excess.

D. $\frac{2}{7}$ mole of Cu_3FeS_3 is in excess.

Question 13 (1 mark)

Inspired from VCAA Chemistry Exam 2007
https://www.vcaa.vic.edu.au/Documents/exams/chemistry/chem1_exam_07.pdf#page=2

When 2.54 g of solid iodine reacts with excess chlorine and the unreacted chlorine is evaporated, 4.67 g of a yellow product remains.

The empirical formula of the product is:

A. ICl_2

B. ICl_3

C. ICl_4

D. ICl_5

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Question 14 (1 mark)

Inspired from VCAA Chemistry Exam 2010
https://www.vcaa.vic.edu.au/Documents/exams/chemistry/2010chem1-w.pdf#page=3

A sample of the insecticide dichlorodiphenyltrichloroethane (DDT), $C_{14}H_9Cl_5$, was found to contain $0.120\ g$ of carbon.

What mass of chlorine was present in the sample?

A. $0.127\ g$

B. $0.355\ g$

C. $0.994\ g$

D. $1.01\ g$

Question 15 (1 mark)

Consider the following reaction:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

If there was $2.0\ g$ of nitrogen gas, then what is the amount of ammonia produced, in grams?

A. $0.61\ g$

B. $1.22\ g$

C. $4.86\ g$

D. $2.43\ g$

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Question 16 (1 mark)

Given the following reaction:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Which amount will produce the greatest amount of product, given that the reaction will go to completion?

A. 1.23 g of H_2.

B. 1.23 g of O_2.

C. 4.55×10^{-2} mol of H_2.

D. 4.55×10^{-2} mol of O_2.

Question 17 (1 mark)

The following reaction occurs in a test tube:

$$2Ag(s) + H_2S(aq) \rightarrow Ag_2S(s) + H_2(g)\ 0.0506$$

If we wanted to produce 12.55 g of Ag_2S, then how much silver, in grams, would we require?

A. 19.34 g

B. 5.46 g

C. 10.92 g

D. 9.67 g

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Question 18 (1 mark)

The following reaction takes place, with 3.45 g of Al and 5.00 g of HCl. What is the limiting reagent?

$$2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(s) + 3H_2(g)$$

A. Al

B. H_2

C. HCl

D. The reaction goes to completion, so neither.

Question 19 (1 mark)

When 5.0 g of Mg reacts with excess HCl, how many grams of H_2 is produced, given the following equation?

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

A. 0.5 g

B. 1.0 g

C. 0.25 g

D. 0.75 g

Question 20 (1 mark)

What is the stoichiometric ratio between the reagent with the lowest molar mass and the product with the highest molar mass in the following reaction?

$$2KMnO_4(aq) + 5FeSO_4(aq) + 8H_2O(l) \rightarrow 5Fe_2O_3(s) + K_2SO_4(aq) + 2MnSO_4(s) + 8H_2SO_4(aq)$$

A. 8: 1

B. 8: 5

C. 4: 1

D. 1: 1

Section H: VCAA-Level Questions II (7 Marks)

INSTRUCTION: 7 Marks. 30 Seconds Reading. 7 Minutes Writing.

Question 21 (7 marks)

Petrol's main ingredient is typically octane, C_8H_{18}, a relatively long hydrocarbon.

a. Petrol can be combusted in the presence of oxygen.

i. If there is a sample of $7.35 \times 10^2\ g$ of octane and $2.24 \times 10^3\ g$ of oxygen gas. Determine the excess and limiting reagents theoretically, if octane and oxygen typically have a $2:25$ ratio. (2 marks)

ii. Based on your answer from **part a. i.**, write the fully balanced reaction. Assume that the only possible carbon-based products are either CO_2 or CO and the reaction occurs at $100°C$. (1 mark)

iii. Find the mass leftover of the excess reagent, in kilograms, using the reaction you identified in **part a. ii.** (2 marks)

b. Octane can be described as hygroscopic, where it repels water fairly well. Explain this phenomenon in relation to octane's polarity and intermolecular bonding. (2 marks)

_____

_____

_____

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Section I: Extension Questions (8 Marks)

Question 22 (8 marks)

Consider the following reaction:

$$Ca(OH)_2(s) + 2HCl(aq) \rightarrow CaCl_2(s) + 2H_2O(l)$$

a. Find the percentage composition of calcium, relative to all reagents. (1 mark)

b. A sample contains 11.23 g of $Ca(OH)_2$ and 14.25 g of HCl.

i. Determine the limiting and excess reagents. (3 marks)

ii. Find the amount of $CaCl_2$ produced. (2 marks)

iii. Find the amount of the excess reagent, in mg, left at the end of the reaction. (2 marks)

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